

## REMARKS

### Amendments

Claim 47 of the application is amended to delete the phrase ``an excess of.''

### Summary of Office Action Dated August 27, 2003

In paragraph 5 of the latest Office Action, (Paper No. 28) the rejection of claims 47-49, 51-53 and 61 as unpatentable over Bertram et al (US 4,592,493, hereinafter the `493 Patent) in view of Ranney et al (US 4,015,044, hereinafter the `044 Patent) was withdrawn in view of the amendment to claim 47 in Paper No. 27. The amendment referred to is the addition of the phrase ``an excess of'' to claim 47, such that limitation (b) of claim 47 states ``...an excess of curing agent comprising isocyanate groups.''

In paragraph 7 of the latest Office Action (Paper No. 28) it is stated that ``an excess of'' is not supported in the specification as originally filed. The Examiner states that the phrase ``1.02:1 to 1.10:1'' recited at page 15 of the specification is support for only that range of volumetric ratios. Further, it is stated that ``an excess of'' means any amount greater than a 1:1 ratio and is, therefore, not supported by the range recited in the specification.

Paragraph 7 of the latest Office Action further states that if the phrase ``an excess of'' is removed from claim 47, the rejection based on the `493 Patent and the `044 Patent will be reinstated.

### Excess of Isocyanate

Applicant has carefully reviewed the file wrapper of the present application and submits that, although the application as originally filed clearly discloses that bonding between the impregnated hydroxyl groups and the isocyanate groups in the thermoset, and discloses the use of an excess of isocyanate groups, it does not state that the invention requires an excess of isocyanate groups. Accordingly, Applicant submits that the importance of using an excess of isocyanate groups has been previously overemphasized.

The application as originally filed clearly discloses that bonding between the impregnated hydroxyl groups and the isocyanate groups in the thermoset:

The face of the sheet facing the corroded substrate is impregnated with a reactive resin that will react with a curing agent for a cellular thermosetting resin (see page 8, lines 9-11 of the present application as originally filed).

Such a treatment impregnates the polyvinyl chloride sheet 28 through that surface 70, leaving hydroxyl ions along with the catalyst on the surface 70 available for bonding with the isocyanate or other bonding agent which is part of the curing agent for the thermosetting resin (see page 14, lines 22-25 of the present application as originally filed).

The side or surface of the sheet section 30 which is to be positioned facing the interior surface 22 of the corroded concrete substrate 18 is treated and activated so as to form a chemical bond with materials included in a thermosetting material, such as, in the case of polyvinyl

chloride, the impregnation of the surface with a substance that results in free hydroxyl ions that will bond chemically with isocyanate in a thermoset curing agent for a thermosetting resin (see page 17, lines 1-7 of the present application as originally filed).

When the thermoset 54 is filled within the space 36, the isocyanate will chemically bond with the available hydroxyl ions embedded to the sheet 28 to create an integrated, composite structure comprising a polyvinyl chloride region at one end, a region on the other end comprising the cellular thermoset material 54, and, in progressing across the cross-section from one to the other, an interphase region 74 where the polyvinyl chloride with its available hydroxyl ions have molecularly integrated with the isocyanate of the cellular thermoset 54 (see page 15, lines 3-9 of the present application as originally filed).

Notably, as seen progressing from the interior to the outside of the conduit, the initially encountered region within this composite, continuous chemically integrated structure is the polyvinyl chloride 28 having its second face 71 facing the interior of the conduit 14. This second face 71 has the ability to withstand chemical deterioration from the corrosive gases, acids and other elements. Continuously progressing toward the outer shell or reach of the conduit 14, the next region 74 comprises the chemically bonded hydroxyl ions with the isocyanates, which themselves are part of the thermoset material 54 (see page 21, lines 22-29 of the present application as originally filed).

#### ``Excess of'' Isocyanato Groups is Desirable

Applicant has previously stated that it is ``imperative'' that the thermosetting material have an excess of isocyanato groups so that these can react with the hydroxyl groups that

have been impregnated in the thermoplastic sheet. While the original specification at page 15, lines 1-2 states that a volumetric ratio of isocyanate to resin of from 1.02:1 to 1.10:1 will provide the necessary quantity of isocyanate, it does not say that this ratio is required for the practice of the invention.

Clearly there will be bonding of isocyanate to hydroxyl groups embedded in the PVC even at very low concentrations of isocyanate since some isocyanate will migrate through the polyurethane to the PVC and bond with embedded hydroxyls. Up to a limit, the larger the concentration of isocyanates in the thermoset the more covalent bonds will be formed between isocyanates in the thermoset and hydroxyl groups in the PVC, resulting in a stronger bond between the thermoset and thermoplastic layers. Thus, although an excess of isocyanates will result in a stronger bond between the layers, a bond will still be formed with no such excess. Consequently, Applicant says that it is not "imperative" that the curing agent has an excess of isocyanato groups, but rather, that an excess within a certain range is desirable in order to maximize the bond strength between the thermoset and thermoplastic layers.

In the last Office Action, it is stated that the range of 1.02:1 to 1.10:1 specified in the application is support only for that range. However, that range was indicated as one in which the necessary quantity of isocyanate is provided. It does not say that below this range there will be insufficient isocyanate to form a bond or that the bond will not be strong enough to practice the invention. It also does not say that above this range no bond or an inadequate bond will form. The range is merely an optimum range for practical purposes.

Accordingly, as long as the thermoplastic material is impregnated with hydroxyl groups, and isocyanato groups are present in the curing agent, an interface of covalent bonds will be formed between the thermoplastic material and thermosetting material of the present invention.

Rejection in Section 8 of the July 18, 2002 Office Action

The Examiner stated that if the phrase ``an excess of'' is removed from claim 47 of the present application, the 35 USC 103 rejection based on Bertram and Ranney will be reinstated. The 35 USC 103 rejection appears in paragraph 8 of the July 16, 2002 Office Action (Paper No. 23).

Paragraph 8 of Paper No. 23 states that the `493 Patent teaches the treatment of concrete or metal surfaces to yield surfaces having polyurethane intermediate layers and polyvinyl chloride (PVC) inner layers bonded thereto. Paragraph 8 further states that the PVC layer may be prepared by flame corona treatment (col. 4, lines 32-36) and coating it with a polyurethane primer-activator (col. 4, lines 42+). The conclusion is then drawn that the `493 Patent's pretreatment of PVC suggests its impregnation with a bonding agent.

Applicant submits that covalent bonds are not formed between impregnated hydroxyl groups and isocyanato groups in the `493 Patent. The `493 Patent, which is issued to Applicant, discusses surface treatment of the thermoplastic sheet, but does not suggest impregnation thereof. The following arguments clearly illustrate that there is no basis in fact and/or technical reasoning to reasonably support a determination that the `493 Patent teaches impregnation of the thermoplastic sheet with a bonding agent.

### Surface Treatment of the '493 Patent

The surface treatment of the '493 patent involves roughening with a flame or corona discharge or by application of methylacetylene propane, (see `493 Patent col. 4, lines 32-50) which creates a micro-profile on the thermoplastic sheet, thereby enabling the thermosetting material to mechanically bond to the thermoplastic sheet. A clear moisture-cured polyurethane primer-activator is then applied to the thermoplastic sheet. The clear moisture-cured polyurethane primer-activator described in the '493 patent forms a covalent bond with the urethane thermosetting material but not with the thermoplastic sheet itself. The bond between the thermoplastic sheet and the clear moisture-cured polyurethane primer-activator is an adhesive bond (i.e., weak forces such as hydrogen bonds, Van der Waals forces, polar-polar bonds, etc.).

The clear moisture-cured polyurethane primer-activator applied to the thermoplastic sheet of the `493 Patent contains aromatic solvents (see `493 Patent col. 4, lines 42-45). However, this is not the same as impregnation of the thermoplastic sheet of the present application with a reactive resin (i.e. hydroxyl-bearing resin). The clear moisture-cured polyurethane primer-activator containing aromatic solvents from the '493 patent does not penetrate and impregnate the thermoplastic sheet. It is, rather, a surface adhesive treatment that has free isocyanate reactive groups available to react and cross-link with hydroxyl groups in the urethane thermosetting material. The bond strength between the moisture-cured polyurethane primer-activator and the thermoplastic sheet of the `493 Patent is not sufficient to transmit and distribute significant amounts stress between the polyurethane and thermoplastic layers. Therefore, the bond between the thermoplastic and polyurethane layers of the `493 Patent is inappropriate for

structural composite sandwich construction. This is due to the fact that the bond is produced at the surface of the thermoplastic sheet, and no penetration or impregnation of the sheet takes place.

#### Treatment of the Thermoplastic Sheet of the Present Invention

The treatment of the thermoplastic sheet of the present invention involves the impregnation of the thermoplastic sheet with a hydroxyl-bearing resin having reactive sites that can form covalent bonds with the urethane thermosetting material. The present application specifically discusses impregnation of the thermoplastic sheet with a reactive resin in the following passages:

The face of the sheet facing the corroded substrate is impregnated with a reactive resin that will react with a curing agent for a cellular thermosetting resin (see page 8, lines 9-11 of the present application as originally filed).

The thermoplastic material of sheet 28 is in the preferred embodiment a polyvinyl chloride. The sheet has two faces. A first face 70 faces the space 36 and interior surface 22 of the substrate 18. The second face 71 faces the interior of the substrate 18. The face 70 facing the space 36 is treated prior to installation within the conduit 14 by treating that surface with 2-propenoic acid, 2-hydroxypropyl ester, polymer with chloroethene and ethenyl acetate reactive resin having a density of 1.37 grams per cubic centimeter at 25 degrees Centigrade and a molecular weight of from 8,000 to 10,000. The reactive resin may contain a catalyst to enhance and cause a preference for a molecular linkage between the thermoplastic sheet 28 and the thermoset material 54. Such treatment impregnates the

polyvinyl chloride sheet 28 through that surface 70, leaving hydroxyl ions along with the catalyst on the surface 70 available for bonding with the isocyanate or other bonding agent which is part of the curing agent for the thermosetting resin (see page 14 lines 13-25 of the present application as originally filed).

The present application additionally discusses preparation of the PVC layer by flame or corona treatment and application of a polyurethane primer-activator, (see page 17, lines 8-14 of the present application) thereby clearly implying that the impregnation steps discussed above are separate and distinct from the flame, corona, or primer activator pretreatment. Therefore, Applicant submits that the Examiner's assertion, that the pretreatment of the PVC disclosed by the `493 Patent includes impregnation with a bonding agent, is inconsistent with the specification of the present application.

The conclusion that the surface treatment of the `493 Patent and impregnation of the present application are separate and distinct is further reinforced by the fact that the present application draws a direct link between the impregnation of the thermoplastic sheet with the reactive resin, the resulting molecular bonding and the improved structural properties of the resulting composite structural conduit:

When the thermoset 54 is filled within the space 36, the isocyanate will chemically bond with the available hydroxyl ions embedded to the sheet 28 to create an integrated, composite structure comprising a polyvinyl chloride region at one end, a region on the other end comprising the cellular thermoset material 54, and, in progressing across the cross-section from one to the other, an interphase region 74 where the polyvinyl chloride with its available hydroxyl ions have molecularly integrated with the



isocyanate of the cellular thermoset 54. This bonding is universal and generally complete over the entire active treated area of the first face 70 of the polyvinyl chloride sheet 28, and the corresponding area of the thermosetting material 54 coming into contact with the face 70 after the thermosetting material cures and sets (see page 15 lines 3-13 of the present application as originally filed).

The side or surface of the sheet section 30 which is to be positioned facing the interior surface 22 of the corroded concrete substrate 18 is treated and activated so as to form a chemical bond with materials included in a thermosetting material, such as, in the case of polyvinyl chloride, the impregnation of the surface with a substance that results in free hydroxyl ions that will bond chemically with isocyanate in a thermoset curing agent for a thermosetting resin (see page 17, lines 1-7 of the present application as originally filed).

The resulting structure, as depicted in the schematic cross-sectional cut-away view or slice in Fig. 9, is a chemically integrated and continuous, composite structure 110 having some five regions, each with differing physical characteristics contributing to a conduit much stronger, more resilient and longer lasting than the conduit, even as originally constructed. Significantly, the resultant structure 110 makes use of the entire pre-existing, corroded substrate 18 and whatever residual strength and physical characteristics the deteriorated substrate 18 possessed prior to restoration (see page 21, lines 14-21 of the present application as originally filed).

The cellular thermoset formed in the middle region of the structure of my invention provides resilient, flexible but tough strength to the resulting composite, integrated material and structure. Further, the bonding between the

various regions is molecular, and is universal substantially throughout the interphases between the proximal regions, which has the advantage of transferring loads from the outside of the conduit throughout the resulting integrated material and structure (see page 27, lines 3-9 of the present application as originally filed).

As is discussed above, the thermoplastic sheet of the present invention can be treated by ionizing or roughening the surface, (see page 17, lines 8-14 of the present application) as can the thermoplastic sheets of the `493 and `392 Patents. However, the present invention additionally involves the impregnation of the thermoplastic sheet with a hydroxyl-bearing resin having reactive sites that can form covalent bonds with the urethane thermosetting material (see page 14, line 13 to page 15 line 13 of the present application). The bond between the hydroxyl-bearing resin and the thermoplastic sheet does not occur only at the surface of the sheet. Rather, the hydroxyl-bearing resin of the present invention penetrates deep into the thermoplastic sheet by means of a solvent solution that swells the thermoplastic sheet. The highly branched, high molecular weight molecules of the hydroxyl-bearing resin are trapped in the matrix of the thermoplastic sheet as the solvent solution evaporates. In addition, compatibility and chemical bonding that occurs between the hydroxyl-bearing resin and the thermoplastic sheet keeps the hydroxyl-bearing resin from diffusing out of the matrix of the thermoplastic sheet. The free hydroxyl groups impregnated inside the thermoplastic sheet are available to react with the free isocyanato groups from the urethane thermosetting material, which diffuses into the internal structure of the thermoplastic sheet. This results in an interphase region between the thermosetting material and the thermoplastic sheet, which is characterized by covalent bonds between the reactive resin impregnated thermoplastic sheet and the

urethane thermosetting material. In contrast, the interface between the thermoplastic sheet and thermoset of the `493 and `392 Patents consists of simple surface adhesive bonds.

The present invention is further distinguished from that of the `493 Patent by the fact that the reliability of the bond between the activated thermoplastic sheet and the urethane thermosetting material of the `493 Patent is affected by ambient moisture content and by application timing. In contrast, since the hydroxyl-bearing resin of the present invention penetrates deep into the thermoplastic sheet it is not susceptible to reaction with ambient moisture, so ambient moisture content and application timing do not affect the quality of the bond. Therefore, the present invention provides a more reliable, stronger bond between the thermoplastic sheet and the thermosetting material.

In conclusion, Applicant submits the above-referenced arguments overcome the Examiner's rejection to claim 47 as being unpatentable under 35 U.S.C. 103(a) over the `493 Patent in view of the `044 Patent, and favorable reconsideration of the Application is respectfully solicited.

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Respectfully submitted,  
By: Geoffrey R. Myers  
Geoffrey R. Myers

Reg. No. 24,897  
Attorney for Applicant

c/o Hall, Priddy, Myers & Vande Sande  
10220 River Road, Suite 200  
Potomac, Maryland 20854  
Tel: (301) 983-2500